SUPPLEMENTAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**62-7995**
SRP Section:	**03.09.03 - ASME Code Class 1, 2, and 3 Components**
Application Section:	**3.9.3**
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Question No. 03.09.03-1

Section 3.9.3.3, “Pump and Valve Operability Assurance,” including Section 3.9.3.3.1, “Operability Assurance Program,” Section 3.9.3.3.2, “Pump Operability,” Section 3.9.3.3.3, “Valve Operability,” and Section 3.9.3.3.4, “Non-NSSS Active ASME Code Class 2 and 3 Pumps and Class 1, 2, and 3 Valves,” in the APR1400 Design Control Document (DCD) Tier 2 describes the functional design and qualification of pumps and valves for the APR1400 reactor. Section 3.9.3.3.1 states that functional design and qualification of safety-related pumps and valves are performed in accordance with ASME Standard QME-1-2007 as endorsed by NRC Regulatory Guide (RG) 1.100. In that the APR1400 DCD specifies the application of ASME QME-1-2007 as endorsed in RG 1.100, the NRC staff requests that the APR1400 design certification applicant clarify the subsections in DCD Section 3.9.3.3 such that they are consistent with the provisions of ASME QME-1-2007 as accepted by RG 1.100 (Revision 3). The following are examples where clarification of these DCD sections is requested:

1. These DCD sections refer to the “operability” of pumps and valves when describing the provisions for the functional capability of pumps and valves. The NRC staff notes that the term “operability” is typically used as part of Technical Specifications in U.S. nuclear power plants. Therefore, the term “functionality” should be used when discussing the qualification of pumps and valves for the APR1400 design.

2. These DCD sections allow the manufacturer to use analysis, test, or a combination of analysis and test in qualifying pumps and valves. Based on performance experience, these provisions should specify that the manufacturer will demonstrate the functionality of pumps and valves by test or a combination of test and analysis consistent with ASME QME-1-2007 as accepted by RG 1.100 (Revision 3).

3. These DCD sections that refer to the use of the ASME OM Code should be revised to include the phrase “as incorporated by reference in 10 CFR 50.55a.”

4. These DCD sections that refer to the use of RG 1.100 should be revised to include the use of ASME QME-1-2007 as accepted in RG 1.100 (Revision 3).

5. These DCD sections should be revised to be consistent with Section 3.9.6.1 when that section is clarified to specify that the functional design and qualification of pumps, valves, and dynamic restraints will be implemented in accordance with ASME QME-1-2007 as accepted in Revision 3 (or later revision) to RG 1.100 unless specific approval for a modification to that methodology is provided by the NRC.

Response

1. The term “operability” used in the referenced DCD sections was utilized since it is a term still used in Regulatory Guide 1.206 “Combined License Applications for Nuclear Power Plants (LWR Edition)”, while the term “operability” included in Revision 2 of SRP 3.9.3 was changed to the term “operational readiness” in Revision 3 of SRP 3.9.3. It is understood that the terms in the DCD sections should be consistent with those indicated in SRP 3.9.3 rather than RG 1.206. Therefore, the term “operability” will be replaced with “functionality (or functional capability)” in the section 3.9.3.3 in APR1400 DCD.

2. The applicable DCD subsections of 3.9.3 will be revised to state that the manufacturer will demonstrate the functionality of pumps and valves by test or a combination of test and analysis consistent with ASME QME-1-2007 as accepted in RG 1.100 (Revision 3).

3. The DCD Section 3.9.3.3.1.e that refers to the use of ASME OM Code will be revised to include the phrase “as incorporated by reference in 10 CFR 50.55a”.

4. The DCD sections that refer to the use of RG 1.100 will be revised to include the phrase “ASME QME-1-2007 as accepted in RG 1.100 (Revision 3)”.

5. This item is under discussion between the industry (e.g., NEI) and the NRC for reviewing the possibility of eliminating Tier 2*. KHNP will update the APR1400 DCD following the resulting methodology that is issued and will ensure consistency with Section 3.9.6.1.

Supplemental Response

This response is being supplemented to include the phrase “ASME QME-1-2007 as accepted in RG 1.100 (Revision 3)” to the markup of Section 3.9.3.3.4.2, “Valves,” which was inadvertently omitted in the original response.

Impact on DCD

DCD Section 3.9.3.3 will be revised as indicated in the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical /Topical/Environmental Reports

There is no impact on any Technical, Topical and Environmental Report.

The design and analysis requirements for the MSSVs, MSADVs, and discharge piping for the steam line are described in Subsection 10.3.2.

A relief valve on each of the SCS suction lines provides LTOP for RCS in a failure that initiates the pressure transient while in shutdown cooling and also can prevent overpressurization of the SCS. These relief valves are addressed in Subsection 5.4.7.

3.9.3.2.3 Pressure Relief Devices for Class 3 Systems and Components

Pressure-relieving devices for ASME Section III Class 3 systems include relief valves and safety valves on heat exchangers, tanks, and piping lines to prevent overpressurization of the components and systems. The thrust load due to the valve opening is usually calculated using static analysis, and the load from static analysis is considered as input to the piping analysis with a dynamic load factor of 2.0. In case the static analysis produces undesirably conservative results, the valve thrust load is accomplished using dynamic analysis.

3.9.3.2.4 Pressure Relief Device Discharge System Design and Analysis

ASME Section III, Appendix O describes two types of discharge systems for pressure relief devices: open-discharge systems and closed-discharge systems. An open-discharge system discharges fluid directly to the atmosphere or to a vent pipe that is open to the atmosphere. A closed-discharge system is hard-piped to a distant location or closed tank. ASME Section III, Appendix O also describes the layout considerations and limits for both types of systems, as well as design equations and considerations for analysis of these systems. The APR1400 design conforms with these requirements.

Functionality

3.9.3.3 Pump and Valve ~~Operability~~ Assurance

3.9.3.3.1 ~~Operability~~ Assurance Program

Functionality

Active pumps and valves are defined as pumps and valves and those components that perform a mechanical motion in order to shut down the plant, maintain the plant in a safe shutdown condition, or mitigate the consequences of a postulated event. The functional design and qualification of safety-related pumps and valves are performed in accordance

with ASME QME-1-2007 (Reference 53) as ~~endorsed by NRC RG 1.100~~ accepted in RG 1.100 (Revision 3). The ~~operability~~ functional capability (performance of this mechanical motion) of active components during and after exposure to design basis events is confirmed by:

a. Designing each component to be capable of performing all safety functions during and following design basis events.

   The design specification includes applicable loading combinations and conservative design limits for active components. The specification requires that the manufacturer demonstrate ~~operability by analysis~~ functional capability, by test, or by a combination of analysis and test.

b. Analysis and/or test demonstrating the ~~operability~~ functional capability of each design under the most severe postulated loadings.

   Methods of ~~operability~~ functional capability demonstration programs are detailed in Subsections 3.9.3.3.2 and 3.9.3.3.3.

c. Inspection of each component to provide reasonable assurance of critical parameter conformance with specifications and drawings.

   This inspection confirms that specified materials and processes are used, that wall thicknesses meet code requirements, and that fits and finishes meet the manufacturer's requirements based on design clearance requirements.

d. Shop testing of each component to verify as-built conditions, as defined in Subsections 3.9.3.3.2 and 3.9.3.3.3.

e. Startup and periodic inservice testing in accordance with ASME OM Code as incorporated by reference in 10 CFR 50.55a to demonstrate that the active pumps and valves are in operating condition throughout the life of the plant.

The combined license (COL) applicant is to identify the site-specific active pumps (COL 3.9(3)).

3.9.3.3.2 Pump ~~Operability~~ [Functionality]

ASME Class 2 and 3 safety-related active pumps are listed in Table 3.9-18. The following criteria are employed in a qualification program to ensure ~~operability~~ [functional capability] of the pumps required to function during and following design basis events.

a. ~~Analysis,~~ [T]test, or a combination of test and analysis are used in accordance with ASME QME-1-2007 as ~~endorsed by NRC RG 1.100~~ [accepted in RG 1.100 (Revision 3)] to confirm the adequacy of the pumps to function over the expected range of service conditions specified, including design basis event and post-design-basis event conditions, as well as inservice testing (IST) conditions.

b. The loads imposed by the attached piping along with the sustained dynamic and seismic loads are taken into account. The design specification includes applicable loading combinations and design stress limits for the pumps. In order to provide reasonable assurance of ~~operability~~ [functional capability] under combined loadings, the stresses resulting from the applied test loads envelop the specified service stress limit for which the pump's ~~operability~~ [functional capability] is intended. Design stress limits applied in evaluating loading combinations are described in Subsection 3.9.3.1.3.

3.9.3.3.3 Valve ~~Operability~~ [Functionality]

Safety-related active valves are listed in Table 3.9-4. ASME Class 1, 2, and 3 valves are designed and analyzed according to the requirements of ASME Section III, subarticles NB/NC/ND-3500.

The following criteria are employed in a qualification program to ensure ~~operability~~ [functional capability] of the valves required to function during and following design basis events.

a. ~~Analysis,~~ [T]test, or a combination of test and analysis are used in accordance with ASME QME-1-2007 as ~~endorsed by NRC RG 1.100~~ [accepted in RG 1.100 (Revision 3)] to confirm the adequacy of the valves to function over the expected range of service conditions specified, including design basis event and post-design-basis event conditions, as well as IST conditions.

b. The loads imposed by the attached piping along with the sustained dynamic and seismic loads are taken into account. The design specification includes applicable loading combinations, and design stress limits for the valves. In order to provide reasonable assurance of ~~operability~~ functional capability under combined loadings, the stresses resulting from the applied test loads envelop the specified service stress limit for which the valve's ~~operability~~ functional capability is intended. Design stress limits applied in evaluating loading combinations are described in Subsection 3.9.3.1.

The safety-related valves are subjected to a series of tests prior to service and during the plant life. Prior to installation, the following tests are performed:

a. Shell hydrostatic test to ASME Section III requirements

b. Backseat and main seat leakage tests

c. Disc hydrostatic test

d. Functional tests to verify that valve opens and closes as required when subjected to the design differential pressure and flow

Cold hydro qualification tests, hot functional qualification tests, and periodic in-service operational tests are performed in situ to verify and provide reasonable assurance of the functional ability of the valves. These tests provide reasonable assurance of the reliability of the valve for the design life of the plant.

3.9.3.3.4 Non-NSSS Active ASME Code Class 2 and 3 Pumps and Class 1, 2, and 3 Valves

3.9.3.3.4.1 Pumps

ASME Class 2 and 3 safety-related active pumps are listed in Table 3.9-18. The following criteria are employed in a qualification program to provide reasonable assurance of ~~operability~~ functional capability of the pumps required to function during and following design basis events.

[T]

a. ~~Analyses,~~ ~~t~~ests, or a combination of analyses and tests are used in accordance with ASME QME-1-2007 as ~~endorsed by NRC RG 1.100~~ to confirm that pumps function adequately over the expected range of service conditions, including design basis events and post-design-basis event conditions, as well as inservice inspections and test conditions.

accepted in RG 1.100 (Revision 3)

b. The loads imposed by the attached piping, along with the sustained dynamic and seismic loads, are taken into account. The design specification includes applicable loading combinations, and design stress limits for the pumps. To provide reasonable assurance of ~~operability~~ under combined loadings, the stresses resulting from the applied test loads envelop the specified service stress limit for which pump ~~operability~~ is intended. Design stress limits applied in evaluating loading combinations are described in Subsection 3.9.3.1.3.

functional capability

3.9.3.3.4.2 Valves

ASME QME-1-2007 as accepted in RG 1.100 (Revision 3)

Reasonable assurance of the ~~operability~~ of active valves is provided to perform a safety-related function during and after the specified plant design basis events. The active valves are seismically and functionally qualified in accordance with ~~NRC RG 1.100~~, and IEEE Std. 344-2004, and are described in Subsection 3.9.6. Subsection 3.9.6 also provides a description of the functional design and qualification provisions and IST programs for safety-related valves.

functional capability

To provide reasonable assurance of the ~~operability~~ of the valves for the plant design life, they are analyzed and/or tested and inspected during construction including the factory tests.

The valves are designed using either stress analysis or conformance with the standard design rules for minimum wall thickness requirements in accordance with the applicable ASME Section III design requirement.

The maximum stress limits used in the analyses are those required by the applicable ASME Section III for the valve that is analyzed. For active valves with extended topworks (e.g., the operator), an analysis of the extended topworks is performed by applying equivalent static seismic loads applied at the center of gravity of the extended topworks.

Prior to installation, functionality and structural integrity tests of the valve are performed as follows:

a. Shell hydrostatic and valve closure tests in accordance with the ASME Section III NB/NC/ND-3530 requirements

b. Functional and operational tests to verify that the valve opens and closes as required when subjected to the design differential pressure and flow

c. ~~Operability~~ Functional capability qualification of motor operators for seismic and environmental conditions, if any, in accordance with IEEE Std. 323-2003, 344-2004, and 382-2006 (References55, 36, and 57)

After installation, the following tests are performed to verify and provide reasonable assurance of the functionality of the valve (References 59, 60, 61, and 62). These tests enhance the reliability of the valve for the design life of the plant.

a. Cold hydrostatic tests

b. Hot functional tests

c. Periodic inservice inspections

d. Periodic inservice operations tests

In addition to the valve qualifications noted above, a representative sample of the valves according to type, load level, and size is tested for ~~operability~~ functional capability during a simulated plant design basis event of an SSE. The seismic qualification of the valves is performed for the SSE preceded by one or more earthquakes. The number of preceding earthquakes is calculated based on Appendix D of IEEE Std. 344-2004.

Selection of damping values for valves to be qualified is determined in accordance with NRC RG 1.61 and IEEE Std. 344-2004. The valve is mounted to represent the typical valve installation or the specified valve installation. The valve includes operators and all

appurtenances that are normally attached to the valve in the plant service. Section 3.10 provides the details of seismic qualification.

The ~~operability~~ functional capability of the active valves with extended topworks during a Level D service (SSE) condition is verified by satisfying the following criteria:

a. The ~~operability~~ functional capability evaluation of the valve is performed by analysis and/or test when subjected to equivalent static load resulting from the accelerations applied at the center of gravity during Level D service conditions.

b. For evaluation by test, the valve is subjected to a static deflection. The valve is operable within the specified operating time limits while an equivalent static load is applied to the extended structure center of gravity in the direction of the weakest axis of the yoke under design pressure.

c. For evaluation by analysis, stresses at critical locations are evaluated and compared to the allowable stress to determine structural integrity, and deflections at critical locations are compared to evaluate ~~operability~~ functional capability.

d. Electrical motor operators and other electrical appurtenances necessary for operation are qualified in accordance with IEEE Std. 382-2006 and IEEE Std. 344-2004.

The active valves without extended topworks, such as check valves and other compact valves, are simple in the valve design, and typically there are no masses causing significant distortions in the affection of the valve operation. Therefore, if these valves are designed so that if structural integrity is maintained, reasonable assurance of valve ~~operability~~ functional capability is considered to be provided.

In addition to the above design considerations, the valves are tested and inspected for in-shop hydrostatic test, in-shop seat leakage test, and periodic valve testing and inspection as installed.

Using the methods as described above, the active valves in the piping system are qualified for the valve ~~operability~~ functional capability during and after an SSE. In addition, these methods